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METHOD FOR LUBRICATING ROLLING STOCK

The invention concerns a method for the rolling of rolling stock, especially for the rolling of hot-rolled wide strip in a finishing train or a continuous casting installation, in which a lubricant is applied directly to the surface of the work rolls or indirectly to the surface of the backup rolls and is then transferred to the surface of the work rolls, before the rolling stock enters the roll gap of a rolling stand, wherein a strongly adherent lubricant film forms on the surface of the work rolls and leads to reduction of friction in the roll gap as an intermediate layer between the roll and the rolling stock.

The use of roll gap lubrication in heavily loaded hot-rolling finishing trains is well known. However, the lubrication is turned on with some delay at the leading end of the strip after the pass has started in the given stand and is turned off a certain amount of time before the trailing end of the strip exits the stand. Depending on the lubricating action, a procedure of this type has an unfavorable effect on the rolling process.

DE 21 05 975 discloses a device for automatically feeding oil to a hot-rolling mill stand through which rolling stock is passing. The device comprises an oil spraying device for the rolling stand, means for feeding oil to the spraying device, means for initiating operation of the oil feed device shortly after the leading end of the rolling stock passes through the rolling stand, and means for terminating operation of the oil feed device shortly before the trailing end of the rolling stock reaches the rolling stand.

The document US 6,266,985 B1 describes a method in which a lubricant is applied to the corners and ends of the rolling stock that is to be hot-rolled.

DE 20 22 923 discloses a method and a device for applying a lubricant to rolling stock in a hot-rolling strip mill, wherein lubricant and atomizing air are delivered to several spray nozzles in a four-high rolling stand equipped with two work rolls and two backup rolls. The spray nozzles are arranged across the width of at least one of the backup rolls. As soon as the rolling stock enters the work rolls, the lubricant is applied to the backup rolls, from which it is transferred to the work rolls. The flow of lubricant and atomizing air to the nozzles is cut off as soon as the rolling stock leaves the work rolls.

The starting time for the lubricant feed is the start of the pass in the given stand. A disadvantage of this method and this device is that a closed lubricant film must first form on the surface of the backup roll and then be transferred to the surface of the work roll in the gap between the backup roll and work roll. From the work roll, the lubricant enters the roll gap. It takes too much time for the lubricant to reach the rolling stock (several seconds), depending on the peripheral speed and diameter of the roll. In a method of this type and a device of this type, the leading end of the strip is not supplied with lubricant as it enters the roll gap, which temporarily results in higher rolling forces.

Fundamentally, rolling is not possible without friction in the roll gap, since sufficient friction is required to bite the rolling stock and pull it through the roll gap. It is always necessary to ensure that the so-called bite and pass conditions are met. With respect to the minimum required friction, the bite condition, which describes the conditions at the leading end of the rolling stock, is much more critical than the pass condition. In the pass condition, the roll gap is completely filled with rolling stock.

If one of the two conditions or both conditions are not satisfied, slipping occurs, i.e., slip between the roll and the

rolling stock.

In addition to the coefficient of friction, which describes the friction itself, the bite angle and the rolling speed play a role. The bite capacity decreases with increasing rolling speed. With respect to the bite angle, which depends on the thickness of the entering rolling stock, the relative thickness reduction during rolling, and the diameter of the rolls, it can be said that it must always be smaller than the friction angle to allow slip-free rolling. With the usual draft distribution, the bite angle in finishing trains decreases from the first to the last stand. Accordingly, the greatest bite problems, mainly slipping at the leading end of the rolling stock, occur in the first finishing stand.

Since the bite condition at the leading end of the rolling stock is more difficult to meet than the pass conditions in the rolling stock, the roll gap lubrication is adjusted in such a way that the lubrication is not turned on until after the initial pass has started in the given stand and is turned off a certain amount of time before the rolling stock exits the stand. This allows the work rolls to continue rolling sufficiently long for the lubricant present on the surface of the rolls to burn off completely. In this way, the bite at the leading end of the following piece of rolling stock is not jeopardized.

As a result of the lubrication strategy described above, two different load levels develop within the rolling stock, provided that the prestrip or the thin slab enters the finishing train with homogeneous properties over the length and without speed-up: a high level at the leading end and the trailing end of the rolling stock (without lubricating action) and a low rolling force level in the remainder of the rolling stock (active lubrication).

As a result of the reduction of the rolling force during active lubrication, which can amount to 50% or more, there is a change in the deflection of the work rolls. This simultaneously results in a change in the state of flatness of the rolling stock (prominent in the rear stands) and in the crown of the rolling stock (prominent in the front stands).

However, if work roll bending is available as an adjusting mechanism in the given stand, then in the case of large rolling force reductions, the adjustment limits are more frequently reached. The result is unstable travel of the rolling stock, especially in the rolling of thin slabs.

It is customary to limit the rolling force reduction to a value of about 20%.

Therefore, the objective of the invention is to specify a method for applying a lubricant to the surface of a work roll or

backup roll, which improves the rolling process, leads to a reduction of roll wear, and lowers the power consumption of the finishing train.

In accordance with the invention, this objective is achieved by the characterizing features of Claim 1. Advantageous refinements of the invention are specified in the dependent claims.

If a lubrication system that feeds lubricant from a reservoir to the work rolls or backup rolls through lines and nozzles is turned on 5-15 seconds before the rolling stock enters the rolling stand, all idle times in the lubrication system are compensated, so that a closed lubricating film always forms on the work roll even before the start of the pass.

The decisive advantage of the method of the invention is that a constant level of rolling force for the given stand is obtained over the entire length of the rolling stock, because the lubrication is maintained over the entire length of the rolling stock.

Due to the constancy of the rolling force, greater total rolling force reductions can be achieved, for example, 40-50%, so that the loading of the rolling train is greatly reduced with respect to wear and power consumption. In addition, the greater rolling force reduction reduces work roll wear and thus

increases the useful life of the rolls (service life).

The advantages of the method of the invention are thus:

- constant rolling force level;
- no change in the state of flatness related to the rolling force;
- no change in strip profile related to the rolling force;
- since the forces at the leading end and the trailing end of the rolling stock are also significantly reduced, stand vibrations and roll damage can be even more effectively avoided;
- this results in greater latitude for draft distributions and thus optimized pass programs for rolling critical products;
- since the state of flatness at the trailing end of the rolling stock does not change due to the rolling force, incorrect rolling of the leading end of the rolling stock can be avoided.

A prerequisite for the use of the lubrication of the invention is that the bite conditions at the leading end of the rolling stock are ensured.

The application of the lubricant in accordance with the invention in a finishing train or a continuous casting installation is advantageously possible without restriction starting with the second stand and for all subsequent stands.

Lubricant is generally not applied in the first finishing

stand due to the great thickness of the rolling stock (large bite angle). In accordance with the invention, in order already to apply the lubricant in the second finishing stand, the conditions existing in the given installation are taken into consideration. These include, for example

- the condition of the surface of the roll after grinding,
- the work roll diameter,
- the work roll material,
- the entering strip thickness,
- the relative reduction that is adjusted,
- the surface condition of the entering rolling stock (scale, temperature, roughness, material, etc.),
- the lubricant used,
- the amount of lubricant, and
- the rolling speed.

If the bite angle is in the critical range, the lubricating action at the leading end of the rolling stock is upwardly limited by a smaller amount of lubricant or by a modified lubricant, i.e., a lubricant with different properties.

When the method of the invention for applying lubricant to a roll surface is used, it is advisable to use the pass program model of the finishing train for this operation. In this regard, at least a doubling of the adaptation matrix should be

provided so as not to adversely affect the adapted operation without roll gap lubrication. In physical models, the selection of different sets of coefficients of friction -- for the lubricated and unlubricated state -- is highly advantageous for the startup, when new products are introduced, and for avoiding high adaptation values.

Every change in friction is associated with a change in the forward slip, i.e., with a change in mass flow or a disturbance of mass flow. This type of disturbance must be stabilized by the automatic control systems, which can lead to considerable difficulties in critical thin strip rolling.

Another advantage of the method of the invention is that, when constant lubrication is provided, constant forward slip is achieved, which in turn results in constant mass flow.

In ferritic rolling, the roll gap lubrication is used to have a favorable effect on the shear texture of the surface. The application of the lubricant in accordance with the invention produces a homogeneous surface texture over the whole length of the rolled product.

To avoid time lags when the lubrication is turned on, the lubrication system is provided with a closed-circulation line with return to the lubricant tank and a switchable 3/2-way valve before the lubricant mixer (for example, a static-tube mixer).